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SERVICE MANUAL

CRT Data Displays
5" 9" 12"

Ball Brothers Research Corporation
SUBSIDIARY OF BALL CORPORATION
ELECTRONIC DISPLAY DIVISION • ST. PAUL, MINNESOTA 55164

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5" 9" 12"

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BALL BROTHERS RESEARCH CORPORATION

ELECTRONIC DISPLAY DIVISION

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CONTENTS

Section			Page
I	GENERAL INFORMATION		
	1.1	General Description	1-1
	1.2	Electrical Specifications	1-1
	1.3	Environmental Specifications	1-2
	1.4	Human Factors Specifications	1-3
	1.5	Controls	1-3
II	INSTALLATION AND OPERATING PROCEDURES		
	2.1	General	2-1
	2.2	Power	2-1
	2.3	Location	2-1
	2.4	Grounding Techniques	2-1
	2.5	Video Lead Routing	2-2
	2.6	Initial Turn On Procedure	2-2
III	THEORY OF OPERATION		
	3.1	Video Amplifier	3-1
	3.2	Vertical Deflection	3-1
	3.3	Horizontal Deflection	3-2
	3.4	Low Voltage Power Supply	3-4
	3.4.1	Standard Low Voltage Power Supply	3-4
	3.4.2	IC Low Voltage Supply	3-5
IV	PRELIMINARY ADJUSTMENTS		
	4.1	Synchronization and Drive Signals	4-1
	4.2	Low Voltage Supply	4-1
	4.3	Brightness	4-1
	4.4	Video Contrast	4-1
	4.5	Vertical Adjustments	4-1
	4.6	Horizontal Adjustments	4-2
	4.7	Focus Adjustment	4-2
	4.8	Centering	4-3
V	TROUBLESHOOTING AND MAINTENANCE		
	5.1	Troubleshooting Guide	5-1
VI	PARTS LIST		
VII	ORDERING AND RETURNING PARTS		
	7.1	Ordering Parts	7-1
	7.2	Returning Parts	7-1

ILLUSTRATIONS

Figure		Page
1	Synchronization and blanking generator waveforms	1-4
2	Voltage Waveform	5-2
3	Interconnecting Cabling Diagram	5-3
4	Circuit Board Components Location	5-4

Section 1
GENERAL INFORMATION

1.1 GENERAL DESCRIPTION

The TV data display monitor is a solid state unit for use in industrial and commercial installations where reliability and high quality video reproduction are desired.

The monitor features printed circuit board construction for reliability and uniformity. All circuits of the monitor are transistorized. The synchronization circuits have been custom designed to accept vertical and horizontal drive signals thus enabling the interfacing of this monitor with industrial or simple sync sources. This feature simplifies the user's sync processing and mixing and allows the unit to operate without requiring composite sync. The electronic packaging has been miniaturized for compatibility with small volume requirements.

1.2 ELECTRICAL SPECIFICATIONS

Input Data Specifications

Input Connector: PWB edge connector, Viking #2VK10S/1-2, Amphenol #225-21031-101, Cinch #250-10-30-170 (BBRC Part Number 1-039-0119)

Input Amplitude: Low zero + 0.4V - 0.0V
High 4.0V ± 1.5V

Video Pulse Width: 100ns or greater

Vertical Drive Rate: 47 to 63 Hz

Horizontal Drive Rate: 15,250 to 16,250 Hz

Rise and Fall Time
(10 to 90% amplitude)

Vertical:	Less than 100ns
Horizontal:	Less than 50ns
Video:	Less than 20ns

Input Signal Format: Refer to Figure 1.

Data Display Specifications

Input Impedance	Minimum Shunt Resistance	Maximum Shunt Capacitance
(a) Video Input (Class A):	3.3 KΩ min.	40-60pF
(b) Vertical Drive Input:	1.2 KΩ	40pF
(c) Horizontal Drive Input:	470 Ω	40pF

Video Amplifier

(a) Bandwidth:	12 MHz (-3 dB)
(b) Rise and Fall Times (10 to 90% amplitude):	Less than 35ns (linear mode)
(c) Storage Time:	15ns max. (linear mode)

Retrace and Delay Times

(a) Vertical: 900µs retrace max.
(b) Horizontal: 7µs retrace plus 4µs delay max.

Display Specifications

Cathode Ray Tube (without bonded panel)

Nominal Diagonal Measurement (inches)	Phosphor	*Resolution (TV lines) Center	Corner
5	P4	650 at 60 fL	550 at 60 fL
9	P4	800 at 40 fL	650 at 40 fL
12	P4	900 at 40 fL	750 at 40 fL
12	P39	900 at 20 fL	750 at 20 fL

*Resolution is measured in accordance with EIA RS-375 except Burst Modulation (or Depth of Modulation) is adjusted for 100 percent.

Geometric Distortion

The perimeter of a full field of characters shall approach an ideal rectangle to within ± 1.5% of the rectangle height.

Power Requirements

TV 9 and 12 with low voltage supply:

Input connector (customer supplied)

Molex connector shell, male, 4 contact, 03-06-1041 (BBRC P/N 1-034-0309)

Molex contacts .063 dia for 20-22 AWG, 4529T (BBRC P/N 1-034-0289)

Input Voltages: 105 to 130 VAC, 50/60 Hz
(optional) 220/240 VAC, 50/60 Hz

TV 5, 9 and 12 using external DC power supply:

Input connector (customer supplied)

	9 & 12	5
Input voltage	15V DC ± .2V	12V DC ± .2V
Ripple	<100mV p-p	<100mV p-p
Input Current	900mA DC nominal	650mA DC nominal
	*1.5A DC max.	*1.0A DC max.

*Brightness and contrast controls adjusted for worst case condition.

1.3 ENVIRONMENTAL SPECIFICATIONS

Temperature (Chassis or Custom Unit)

Operating Range: 5°C to 55°C Ambient
Storage Range: -40° to 65°C

Humidity

5 to 80% (noncondensing)

Altitude

Operating Range Up to 10,000 feet

1.4 HUMAN FACTORS SPECIFICATIONS

X-Ray Radiation

The TV units comply with DHEW Radiation Performance Standards 21CFR, subchapter J.

1.5 CONTROLS

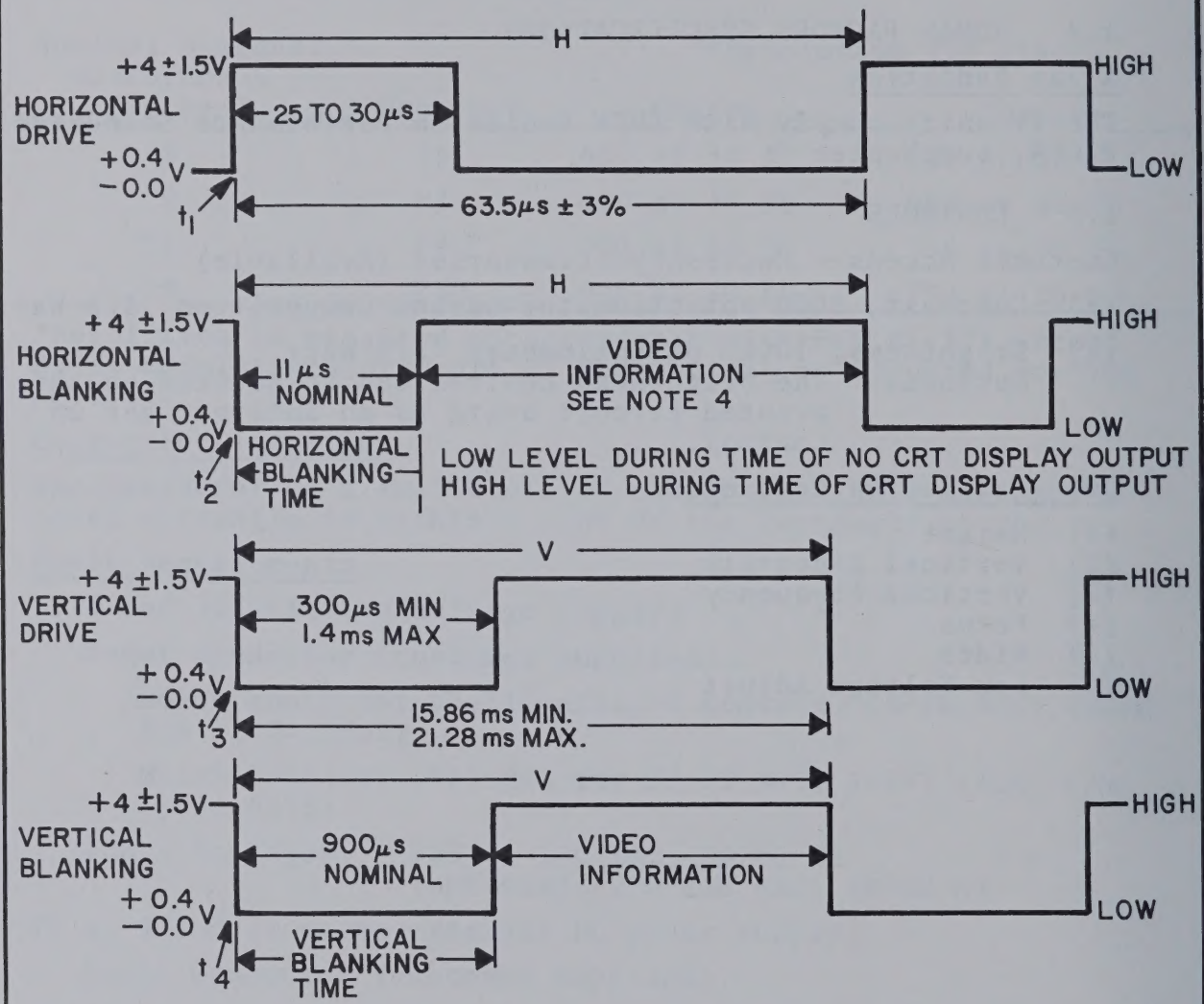
Customer Access - Necessary Accessories (Available)

(1) Contrast, 500Ω potentiometer carbon composition 1/8 Watt

(2) Brightness, 100kΩ potentiometer 1/8 Watt
Optional: The brightness control can be mounted on the printed circuit board as an internal set up control.

Internal Set Up Controls

(1) Height
(2) Vertical Linearity
(3) Vertical Frequency
(4) Focus
(5) Width
(6) Low Voltage Adjust



NOTES:

1. t_1 and t_3 initiate horizontal and vertical retrace respectively. The relative difference between t_1 and t_2 and t_3 and t_4 should be chosen to center the video within the raster horizontally and vertically.
2. H= time from start of one line to start of next line.
3. V= time from start of one field to start of next field.
4. Video pulse width should be equal to or greater than 100ns.

Fig 1 Synchronization and blanking generator waveforms.

Section 2

INSTALLATION AND OPERATING PROCEDURES

2.1 GENERAL

This section describes the installation procedures of the TV monitor. It also contains information on the power, location, installation and initial turn-on procedures.

2.2 POWER

The power requirements for the TV units that have a self contained power supply is 120 VAC, 50/60 Hz except for units that are wired for 220/240 V, 50/60 Hz operation.

The AC voltage is applied to the unit via a 4 contact female connector shell (Molex #03-06-2041) with male contacts (Molex #1560T).

The power supply mating connector (supplied by the customer) is a 4 contact male connector shell (Molex #03-06-1041) with female contacts (Molex #4529T).

2.3 LOCATION

The TV unit shall not be located in an area that restricts a flow around the unit. Nor shall it be placed near any heat generating sources, since this may cause the unit to over heat.

2.4 GROUNDING TECHNIQUES

The method of interconnecting and grounding the equipment is a function of the signal frequency; and optimum grounding depends largely on the system in which the equipment is used.

The following grounding technique is recommended when installing a TV Data Display Monitor.

The vertical/video, horizontal drive, vertical drive, and CRT arc bypass are all returned to the TV chassis plate ground through single molex connections. Normally, it is assumed that the frame and chassis plate of the monitor will be installed in a system where they will be an integral part of system ground. If this is true, then further grounding should not be necessary. The mating of monitor's frame with the system or the generator's signal source ground must be electrically good. Good electrical metal-to-metal contact must be assured.

Where strong radiated noise and signal fields inhibit the monitor's operation or where a signal's waveform is deteriorated by long or poorly selected cabling, the proper shielded cable should be used. When using shielded cable, careful attention must be given to proper grounding of the outer conductor. Improper grounding can cause ground loops. In some cases, transistor failures can be traced to poor grounding techniques.

The TV monitor has provisions at the printed circuit board edge connector to pick up the ground returns for the vertical/video, horizontal drive, and vertical drive circuits. If these connections must be used, it is likely that the single molex connection associated with each ground return may have to be opened to minimize ground loops. Reducing the number of ground connections reduces the number of possible ground loops with the ultimate being one system ground connection at the source.

IMPORTANT - - One pin on the printed circuit board edge connector is to be used specifically for the CRT arc bypass and must not be used as a signal ground return (see schematic).

2.5 VIDEO LEAD ROUTING

The video lead probably will carry high frequency signals and should be given the following considerations:

A. To minimize distributed capacity and capacitive pickup of nearby radiated fields, route the video leads separately and away from all other wiring.

B. Make the lead length as short as possible, consistent with the packaging requirements.

C. Ideally, the video line should meet the requirements of a terminated coaxial system; i.e., the video line should exhibit a constant impedance from source to load. An effective method of testing the video line is as follows:

   a. Establish a configuration and keep the foregoing requirements in mind.

   b. Drive the source end of the video line with the output of TTL logic or an equivalent pulse generator capable of providing pulses with rise and fall times of typically 10 nanoseconds and pulse widths of approximately 100 nanoseconds. Any convenient duty cycle and repetition rate may be used. The generator should be capable of supplying +2.5 Volt pulse.

   c. Observe the pulse at the receiving end of the video line with a low capacitance (less than 5pF) oscilloscope probe. Adjust the routing and termination of the video line to maintain rise and fall times of 20 nanoseconds or less and overshoots within 10 percent of the pulse amplitude.

2.6 INITIAL TURN-ON PROCEDURE

Connect the video and synchronization signals to the monitor and then apply power to the unit. Place the power switch (external or internal) in the ON position. Adjust the brightness and contrast controls for desired effect and stabilize the picture with the vertical hold control. Adjust the focus control to produce optimum focus over the entire area of the CRT.

For normal operation of the monitor after it has been adjusted, turn on power and adjust contrast and brightness controls.

Section 3
THEORY OF OPERATION

3.1 VIDEO AMPLIFIER

The video amplifier consists of Q101 and its associated circuitry.

The incoming video signal is applied to the monitor through the contrast control and R109 to the base of transistor Q101.

Transistor Q101 and its components comprise the video output driver with a gain of about 17. Q101 operates as a class B amplifier and remains cutoff until a DC-coupled, positive-going signal arrives at its base. R111 provides series feedback which makes the terminal-to-terminal voltage gain relatively independent of transistor variations as well as stabilizes the device against voltage and current changes caused by ambient temperature variation. C118 bypasses the AC signal around the bias network.

The negative going signal at the collector of Q101 is DC-coupled to the cathode of the CRT. The class B biasing of the video driver allows a larger video output signal to modulate the CRT's cathode and results in a maximum available contrast ratio.

The overall brightness at the screen of the CRT is determined by the negative potential at the grid and is varied by the brightness control.

3.2 VERTICAL DEFLECTION

Transistor Q102 is a programmable unijunction transistor, and together with its external circuitry, forms a relaxation oscillator operating at the vertical rate. Resistor R115, variable resistor R116 and capacitors C105 and C106 form a RC network providing proper timing.

When power is applied, C105 and C106 charge exponentially through R115 and R116 until the voltage at the junction of R116 and C105 equals the anode "A" firing voltage. At this time, one of the unijunction's diodes that is connected between the anode and anode gate "G" becomes forward biased allowing the capacitors to discharge through another diode junction between the anode gate and the cathode "K" and on through R120.

R117 and R118 control the voltage at which the diode (anode-to-anode gate) becomes forward biased. This feature "programs" the firing of Q102 and prevents the unijunction from controlling this parameter. Therefore, the changing of firing points from one device to another, together with the temperature dependency of this parameter, is no longer a problem as it can be with conventional unijunction transistors.

The vertical oscillator is synchronized externally to the vertical interval from the vertical drive pulse at R113. At the time of the vertical interval, an external negative pulse is applied

through R113, C104, and CR101 to the gate of Q102, causing the firing level of the unijunction to decrease.

The sawtooth voltage at the anode of Q102 is directly coupled to the base of Q103. Q103 is a driver amplifier and has two transistors wired as a Darlington pair; their input and output leads exit as a three-terminal device. This device exhibits a high input impedance to Q102, and thereby maintains excellent impedance isolation between Q102 and Q104.

The output waveform from the unijunction oscillator is not suitable, as yet, to produce a satisfactory vertical sweep. Such a waveform would produce severe stretching at the top of the picture and compression at the bottom. C105 and C106 modify the output waveform to produce satisfactory linearity. The sawtooth waveform output at Q103 is coupled through R122, the vertical linearity control R121, and on to C106 where the waveform is shaped into a parabola. This parabolic waveform is then added to the oscillator's waveform and changes its slope. Slope change rate is determined by the position of R121.

Q103 supplies base current through R123 and R124 to the vertical output transistor, Q104. Height control R124 varies the amplitude of the sawtooth voltage present at the base of Q104 and varies the size of the vertical raster on the CRT.

The vertical output stage, Q104, uses a power type transistor which operates as a class A amplifier. No output transformer is required since the output impedance of the transistor permits a proper impedance match with the yoke connected directly to the collector. C107 is a DC blocking capacitor which allows only AC voltages to produce yoke current. L1 is a relative high impedance compared to the yoke inductance. During retrace time, a large positive pulse is developed by L1 which reverses the current through the yoke and moves the beam from the bottom of the screen to the top. Resistor R126 prevents oscillations by providing damping across the vertical deflection coils.

3.3 HORIZONTAL DEFLECTION

A driver stage consisting of Q105 and T101 is used to obtain a signal to drive Q106, the horizontal output transistor. The circuitry associated with Q105 and Q106 has been designed to optimize the efficiency and reliability of the horizontal deflection circuits.

A positive going pulse is coupled through R127 to the base of Q105. The amplitude and duty cycle of this waveform must be as indicated in the electrical specifications (Section 1.2) for proper circuit operation.

The driver stage is either cut off or driven into saturation by the base signal. The output signal appears as a rectangular waveform and is transformer-coupled to the base of the horizontal output stage. The polarity of the voltage at the secondary of the

driver transformer is chosen such that Q106 is cut off when Q105 conducts and vice versa.

During conduction of the driver transistor, energy is stored in the coupling transformer. The voltage at the secondary is then positive and keeps Q106 cut off. As soon as the primary current of T101 is interrupted due to the base signal driving Q105 into cut off, the secondary voltage changes polarity. Q106 starts conducting and its base current starts to flow. This gradually decreases at a rate determined by the transformer inductance and circuit resistance.

The horizontal output stage has five main functions; to supply the yoke with the correct horizontal scanning current; develop 340V (5") or 400V (9" & 12") for use with the CRT; develop 26V (5") or 34V (9" & 12") for the video output stage; and develop -120V (5") or -160V (9" & 12") for the CRT bias.

Q106 acts as a switch which is turned on or off by the rectangular waveform on the base. When Q106 is turned on, the supply voltage plus the charge on C113 causes yoke current to increase in a linear manner and moves the beam from near the center of the screen to the right side. At this time, the transistor is turned off by a positive voltage on its base which causes the output circuit to oscillate. A high reactive voltage in the form of a half cycle negative voltage pulse is developed by the yoke's inductance and the primary of T2. The peak magnetic energy which was stored in the yoke during scan time is then transferred to C109 and the yoke's distributed capacity. During this cycle, the beam is returned to the center of the screen.

The distributed capacity now discharges into the yoke and induces a current in a direction opposite to the current of the previous part of the cycle. The magnetic field thus created around the yoke moves the scanning beam to the left of the screen.

After slightly more than half a cycle, the voltage across C109 biases the damper diode CR103 into conduction and prevents the flyback pulse from oscillating. The magnetic energy that was stored in the yoke from the discharge of the distributed capacity is released to provide sweep for the first half of scan and to charge C113 through the rectifying action of the damper diode. The beam is then at the center of the screen. The cycle will repeat as soon as the base voltage of Q106 becomes negative.

C113, in series with the yoke, also serves to block DC currents through the yoke and to provide "S" shaping of the current waveform. "S" shaping compensates for stretching at the left and right sides of the picture tube because the curvature of the CRT face and the deflected beam do not describe the same arc.

L101 is an adjustable width control placed in series with the horizontal deflection coils. The variable inductive reactance allows a greater or lesser amount of the deflection current to flow through the horizontal yoke and, therefore, varies the width of the horizontal scan.

The negative flyback pulse developed during horizontal retrace time is rectified by CR104 and filtered by C110. This voltage is coupled through the brightness control to the grid of the CRT (V1).

This same pulse is transformer-coupled to the secondary of transformer T2 where it is rectified by CR2, CR106 and CR105 to provide the CRT ultor voltage, the focus and video amplifier operating voltages.

3.4 LOW VOLTAGE POWER SUPPLY

The TV 9 and 12 are available with two internal power supplies. The standard supply consists of a power supply module with a separate regulator board. The optional supply consists of a power supply module with the series pass transistor replaced with an IC regulator in a TO-3 package.

The 120 VAC primary voltage (220/240V, optional) is stepped down at the secondary of T1 and is rectified by a full wave bridge CR1. Capacitor C1 is used to smooth out the rectified output of CR1.

3.4.1 STANDARD LOW VOLTAGE POWER SUPPLY

This power supply uses a series pass transistor Q1 and a low voltage regulator board to maintain a constant DC output. A current limiting circuit is incorporated to protect the transistor in the 15 volt line from accidental short circuit and load malfunction.

Q1 is in series with the load and its output voltage will vary with change in line voltage and circuit loading. Q202 is a DC amplifier and compares the output voltage to a reference voltage provided by VR201 (5.6V zener). An error voltage is applied to the base of Q201, an emitter follower which regulates Q1 output voltage.

Assume that the output voltage has increase above the nominal setting of 15V. This raises the voltage at the base of Q202 and change the bias voltage of Q201. Since the emitter of Q201 is direct coupled to the base of Q1, it causes Q1 to conduct less and brings the regulated voltage back to 15V.

For short circuit protection or current limiting action, assume the 15V line is shorted to ground. The reduce output voltage decrease the base potential of Q202 and drives it to cutoff. Simultaneously, the increase current through R204 increases the emitter base voltage of Q203 and turns it on. Prior to the short circuit condition, Q203 is at cutoff. The increase collector current through R202 changes the base voltage of Q1 and causes its output current to decrease accordingly. This closed loop operation maintains the current available to any transistor connected to the 15V line at a safe level during the short circuit condition.

3.4.2 IC LOW VOLTAGE SUPPLY

The series pass transistor has been replaced with an IC regulator. The resistor R1 across the input/output terminal is used to limit the power dissipation of the IC. The regulator maintains the output voltage at 15V and provides current limiting and short circuit protection.

Section 4

PRELIMINARY ADJUSTMENTS

4.1 SYNCHRONIZATION AND DRIVE SIGNALS

Apply horizontal and vertical drive signals to the horizontal and vertical drive terminals as indicated on your schematic. Adjust their levels to a nominal +4V peak-to-peak. The duty cycle of each signal must be adjusted as described in Section 1.2.

The horizontal drive signal is required to initiate horizontal scan and high voltage, and should be connected before applying power to the monitor.

4.2 LOW VOLTAGE SUPPLY

For units which have a self-contained low voltage power supply, set the DC voltage by variable resistor R208 to 15V. This voltage can be monitored at the junction of R114 and R130.

Monitors that use an external DC supply must supply the voltage as specified in Section 1.2.

4.3 BRIGHTNESS

Normally, the monitor will be used to diplay alphanumeric or other black and white information. Moreover, the video polarity is usually white characters on a black background.

The brightness control should be adjusted at a point where the white raster is just extinguished. The CRT will then be at its cutoff point, and a maximum contrast ratio can be obtained when a video signal is applied.

4.4 VIDEO CONTRAST

Q101 is designed to operate linearly when a +2.5V signal is applied to its base. Some models incorporate a 500 ohm external contrast control to maintain this level. This control, or a fixed resistor, should be adjusted for a typical signal level of +2.5V peak-to-peak when measured at the video input terminal of the printed circuit board edge connector. (Refer to the schematic.)

In all cases, the output DC impedance of the video signal source must be 500 ohms, or less.

4.5 VERTICAL ADJUSTMENTS

There is a slight interaction among the vertical frequency, height, and linearity control. A change in the height of the picture may affect linearity.

(1) Apply video and synchronization signals to the monitor.

(2) Set the vertical frequency control R116 near the mechanical center of its rotation.

(3) Adjust the vertical height control R124 for desired height.

(4) Adjust the vertical linearity control R121 for best vertical linearity.

(5) Remove the vertical drive signal from the unit. Or, alternatively, use a short jumper lead, and short the vertical drive input terminal of the printed circuit card edge connector to ground.

(6) Readjust the vertical frequency control R116 until the picture rolls up slowly.

(7) Restore vertical drive to the monitor.

(8) Recheck height and linearity.

4.6 HORIZONTAL ADJUSTMENTS

Raster width is affected by a combination of the low voltage supply, width coil L101, and the horizontal linearity sleeve located on the neck of the CRT beneath the yoke.

(1) Apply video and synchronization signals to the monitor. Insert the horizontal lineariyt sleeve about 2/3 of its length under the yoke. (If you received a monitor from the factory in which the placement of the linearity sleeve has been determined, make a mark on the sleeve and re-insert the sleeve to this mark when removal of the yoke and linearity sleeve are required.)

If the linearity sleeve is inserted farther than necessary, excessive power will be consumed, and the horizontal output circuitry could be overstressed.

(2) Adjust the horizontal width coil L101 for the desired width.

(3) Insert the linearity sleeve farther under the yoke to obtain the best linearity. Although this adjustment will affect the raster width, it should not be used solely for that purpose. The placement of the linearity sleeve should be optimized for the best linearity.

(4) Readjust L101 for proper width.

(5) Observe final horizontal linearity and width, and touch up either adjustment if needed.

No horizontal hold control is used in this monitor. The raster should be properly locked and centered when the horizontal drive signals as described in Section 1.2 are used.

4.7 FOCUS ADJUSTMENT

The focus control R107 provides an adjustment for maintaining best overall display focus. This control does not have a large effect on focus because of the CRT gun assembly construction.

4.8 CENTERING

If the raster is not properly centered, it may be repositioned by rotating the ring magnets behind the deflection yoke.

The ring magnets should not be used to offset the raster from its nominal center position because it would degrade the resolution of the display.

If the picture is tilted, rotate the entire yoke.

Section 5
TROUBLESHOOTING AND MAINTENANCE

5.1 TROUBLESHOOTING GUIDE

Symptoms	Check	Action
No control of brightness level	Check for a DC volt- at pin 4 of 10 pin edge connector (or wiper of brightness control) for a -150V DC to +30V DC as brightness control is rotated	If -150V DC isn't present check CR105. If -150V DC is present replace CRT.
Insufficient Vert Hold Range		Replace Q102
Low High Voltage		Replace HV rectifier CR2.
Hum in raster	Shunt C1 with equivalent capacitor.	If symptoms are removed replace C1.
Hum in raster & PS doesn't regulate	Check Q1 for short.	
No brightness	Observe lighted filament in CRT	If filament isn't lighted, check with ohmmeter. If no continuity, replace CRT.
Monitor is dead	Check for HV on CRT anode (11kV) If no HV is present, check LV supply +15V DC NOTE: LV supply will indicate low or 0 volts due to its current limiting action if a short is evident in the "A" volt line.	If LV isn't present, remove plug P104. If B+ is restored replace Q106. With P104 removed and B+ is still not present, check for approximately 22V DC on collector of Q1. If voltage is present, with P104 removed check Q202 Q203, and VR201. On models without PS check fuse F101.

The voltage waveforms are shown in Fig. 2 and Fig. 3 is the interconnecting cabling diagram. Fig. 4 shows the circuit board component locations.

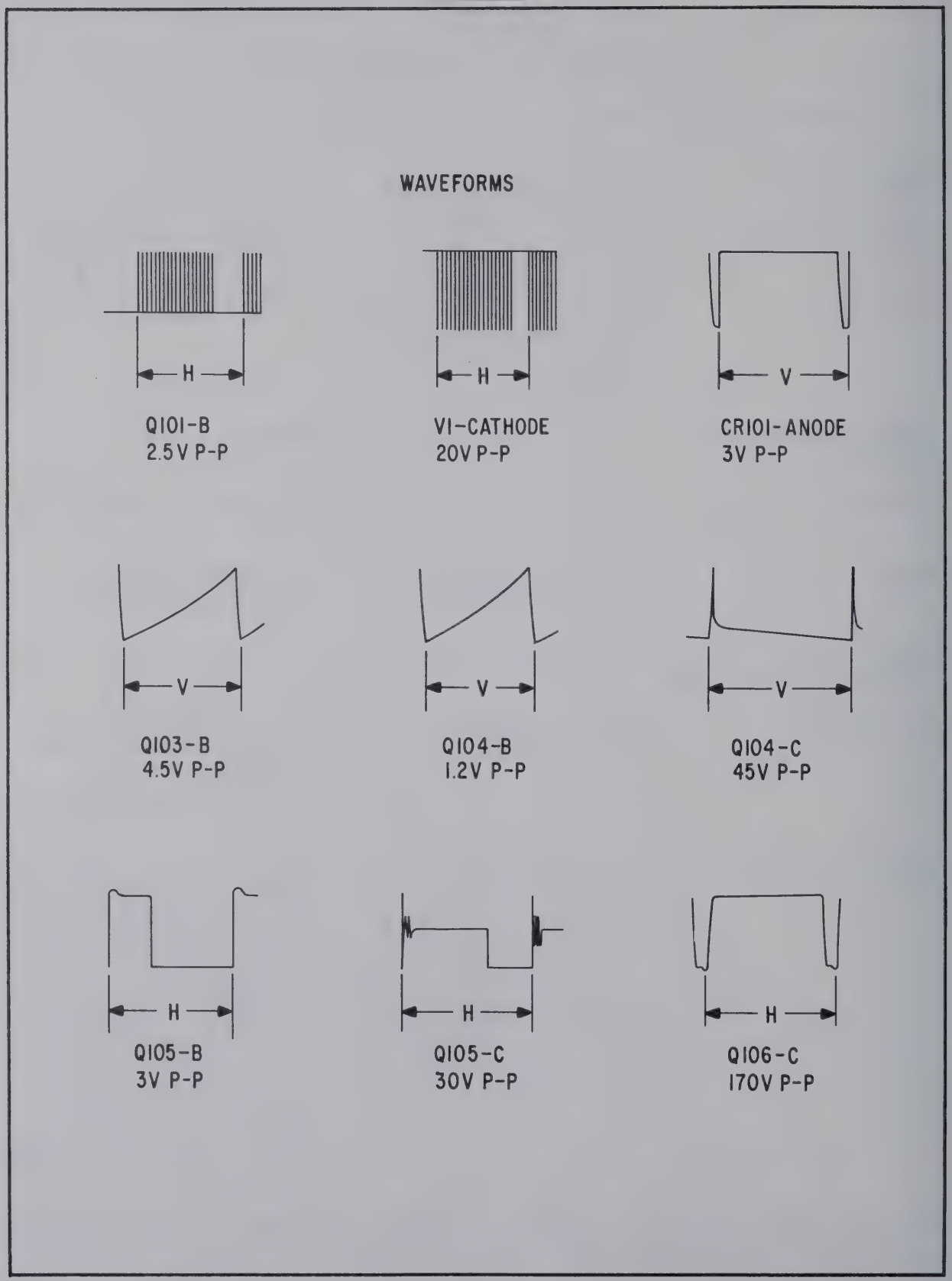


Fig. 2 Voltage Waveform

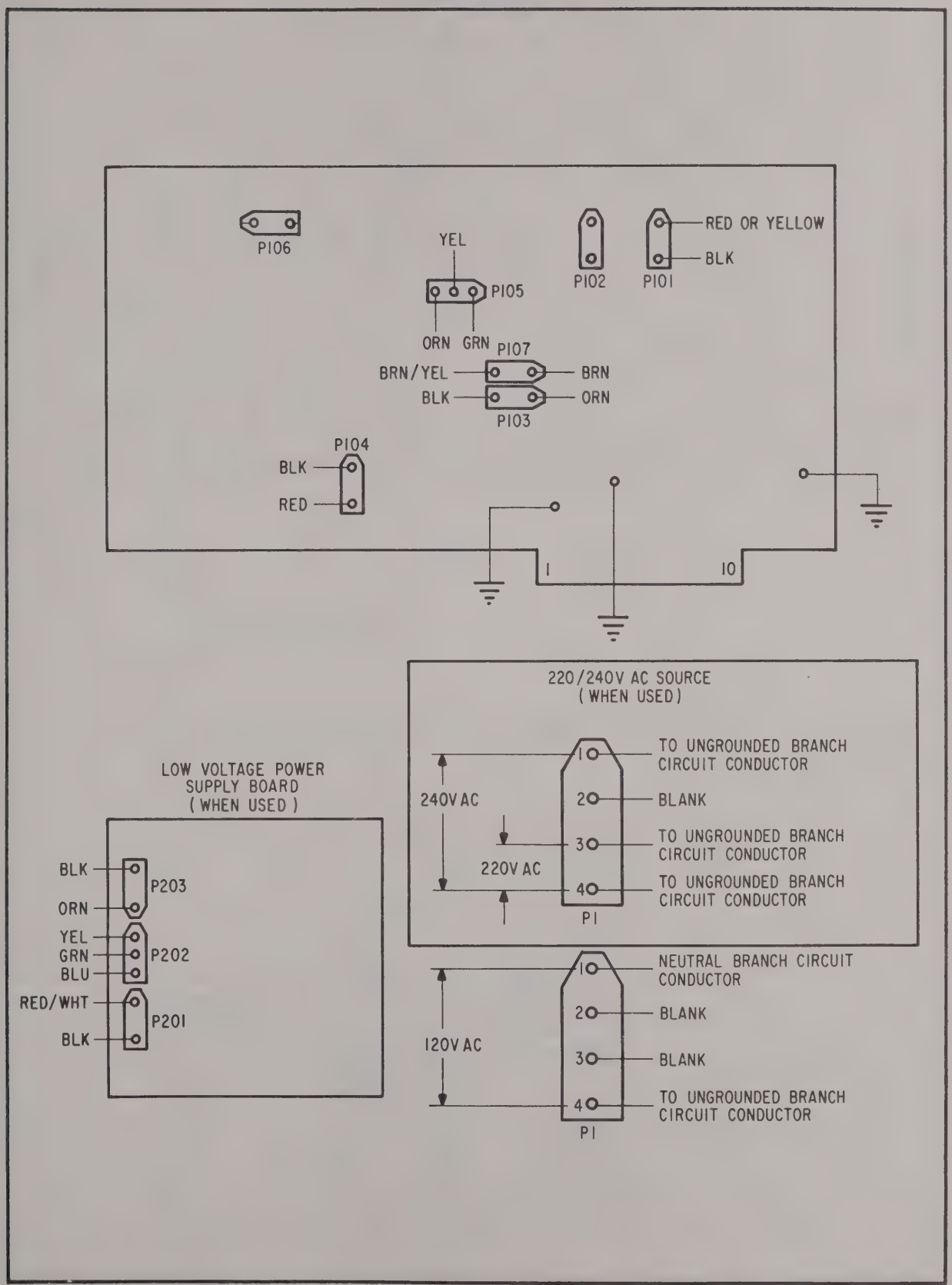
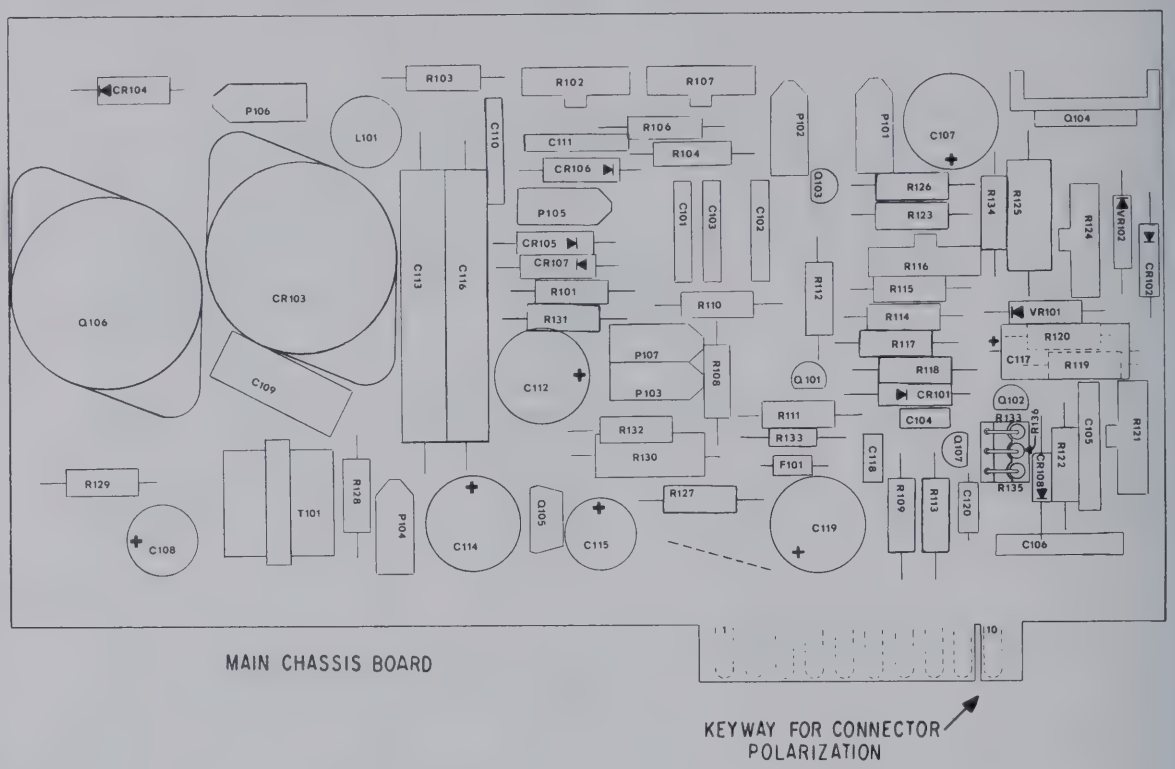


Fig. 3 Interconnecting Cabling Diagram



NOTE:

F101 AND R108 ARE USED ONLY WHEN LOW VOLTAGE POWER SUPPLY IS NOT SUPPLIED.

C116 IS USED ON 5 INCH MODELS ONLY

R102 (BRIGHTNESS POT) IS OPTIONAL

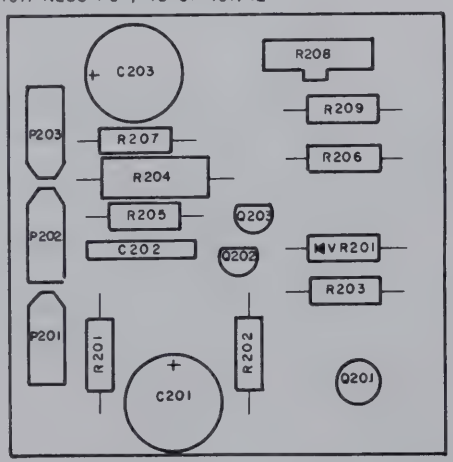


Fig. 4 Circuit Board Components Location

Section 6

PARTS LIST

SYM		DESCRIPTION	BBRC PART NUMBER
		CAPACITOR, Fixed: µf unless otherwise stated	
C1		3300; 60V, electrolytic	1-012-2156
C101		0.01; 1000V, ceramic arc gap	1-012-0112
C102		0.01; 1000V, ceramic arc gap	1-012-0112
C103		0.01; 1000V, ceramic arc gap	1-012-0112
C104		0.001 ± 10%; 1000V, ceramic disc	1-012-0540
	or	0.005 ± 20%; 500V, ceramic disc	10-12-7508
C105		0.47 ± 10%; 100V, mylar	1-012-1005
C106		0.47 ± 10%; 100V, mylar	1-012-1005
C107		500; 6V, electrolytic	1-012-2158
C108		100; 6V, electrolytic	1-012-2160
C109		0.022 ± 10%; 400V, mylar	1-012-0800
	or	0.033 ± 10%; 400V, mylar	1-012-0804
	or	0.015 ± 10%; 400V, mylar	1-012-2153
	or	0.027 ± 10%; 400V, mylar	1-012-2237
C110		0.047 ± 10%; 200V, mylar	1-012-2240
C111		0.02 ± 20%; 1000V, ceramic disc	1-012-0780
C112		50; 50V, electrolytic	1-012-2157
C113		10 ± 10%; 63V, mylar	1-012-1130
	or	10 ± 10%; 63V, polycarbonate	1-012-2235
C114		200; 25V, electrolytic	1-012-2159
C115		50; 25V, electrolytic	1-012-2165
C116		20; 150V, electrolytic (5" only)	1-012-1260
C117		6µf; 25V, electrolytic	1-012-2066
C118		820pf ± 5%; 500V, dipped mica	1-012-0482
	or	470pf ± 5%; 500V, dipped mica (TV-B12)	1-012-0460
	or	360pf ± 5%; 500V, dipped mica	1-012-2241
	or	100pf ± 5%; 500V, dipped mica	1-012-0300
	or	680pf ± 5%; 300V, dipped mica	10-57-5681
C119		25; 50V, electrolytic	1-012-2193
C120		0.01 ± 20%; 1000V, ceramic disc	1-012-0740
C201		50; 50V, electrolytic	1-012-2157
C202		0.01 ± 20%; 1000V, ceramic disc	1-012-0780
C203		50; 50V, electrolytic	1-012-2157
CR1		VS148, bridge rectifier	1-021-0413
CR2		H510, High voltage rectifier	1-021-0424
CR101		1N3605	1-021-0410
CR102		1N3605	1-021-0410
CR103		1N4785	1-021-0360
CR104		1N3279	1-021-0380
CR105		1N3279	1-021-0380
CR106		1N3279	1-021-0380
CR107		1N3279	1-021-0380
CR108		1N3605	1-021-0410

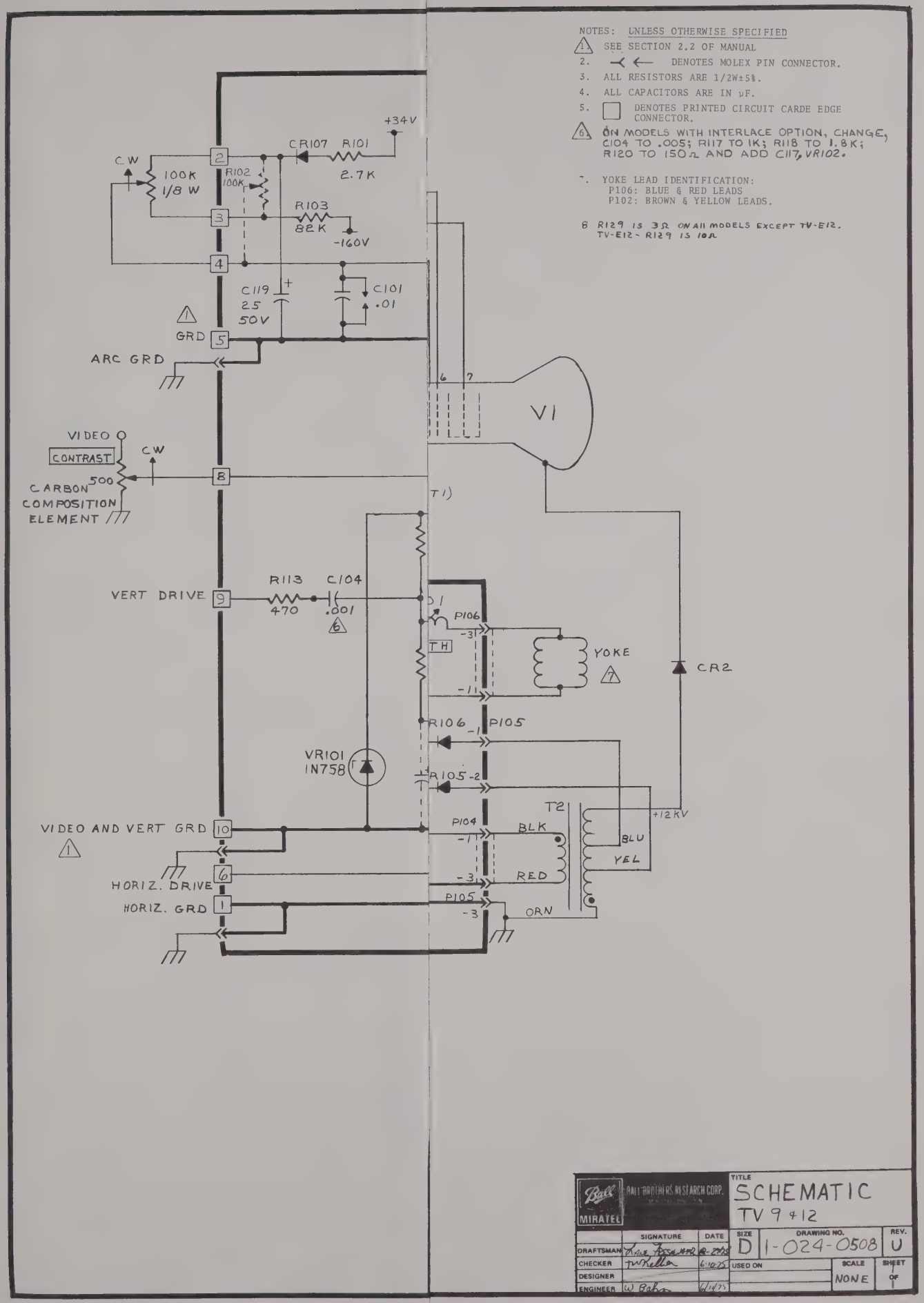
F1		Fuse, 0.6A-250V, ¼ X 1¼, slo-blo	1-028-0244
	or	Fuse, 0.6A-250V, 9/32 X 1¼, slo-blo (TV0B12)	1-028-0245
	or	Fuse, 0.3A ¼ X 1¼	1-028-0241
	or	Fuse, 0.3A 1¼ X 9/32	1-028-0250
F101		Fuse, 2A-125V, picofuse	1-028-0247
L1		Vertical choke (TV 5 & 12)	6-003-0321
	or	Vertical choke (TV 9)	6-003-0352
L101		Coil, width	1-016-0303
	or	coil, width	1-016-0299
	or	Coil, width	1-016-0279
		TRANSISTOR	
Q1		2N3055	1-015-1134
Q101		2N5830	1-015-1172
Q102		2N6027	1-015-1157
Q103		MPSA14	1-015-1158
Q104		MJE3055	1-015-1156
Q105		MPS-U05	1-015-1159
Q106		B1182	1-015-1182
	or	B1182, orange dot	1-015-1191
	or	B1182	1-015-1194
	or	B1182, blue dot	1-015-1198
	or	B1196	1-015-1196
Q107		2N4124	1-015-1139
Q201		2N3053	1-015-1143
Q202		2N3903	1-015-1132
Q203		2N3903	1-015-1132
		RESISTOR, Film ½W ± 5%; unless otherwise stated	
R101		2.7k	1-011-2280
R102		Var; 100k ± 20%; 1/8W (optional)	1-011-5435
R103		82k	1-011-2316
R104		100k	1-011-2318
R105		Not Used	
R106		100k	1-011-2318
R107		Var; 2.5M ± 20%; 1/8W, composition	1-011-5566
R108		15Ω, (TV 12 W/O power supply)	1-011-2226
	or	22Ω, 1W, composition (TV-C12 only)	1-011-2421
R109		47Ω	1-011-2238
R110		820Ω	1-011-2268
R111		47Ω	1-011-2238
R112		220Ω	1-011-2254
R113		470Ω	1-011-2262
R114		150Ω, (TV 9 & 12)	1-011-2250
	or	68Ω, (TV 5)	1-011-2242
R115		82k	1-011-2316
R116		Var; 100k ± 20%; 1/8W, composition	1-011-5435
R117		4.7k	1-011-2286
	or	1k	1-011-2270
R118		8.2k	1-011-2292
	or	1.8k	1-011-2276

R119		100k	1-011-2318
R120		560Ω	1-011-2264
	or	150Ω	1-011-2250
R121		Var; 10k ± 20%; 1/8W, composition	1-011-5312
R122		4.7k	1-011-2286
R123		56Ω	1-011-2240
	or	120Ω	1-011-2248
R124		Var; 250Ω± 20%; 1/8W, composition	70-89-0251
R125		6,8Ω ± 10%; 2W, wirewound	1-011-2406
	or	1.8Ω ± 10%; 2W, wirewound	1-011-2417
R126		680Ω	1-011-2266
R127		470Ω	1-011-2262
R128		2.7k	1-011-2280
R129		3Ω	1-011-2478
	or	10Ω	1-011-2222
R130		1.2Ω ± 10%; 2W, wirewound	1-011-1395
R131	1	3.3k	1-011-2282
R132		82Ω ± 10%; 2W, wirewound	1-011-2375
R133		4.7k; ¼W	70-16-0472
R134		Not used	
R135		22k; ¼W	70-16-0223
R136		22k; ¼W	70-16-0223
R137		68k; 1W	1-011-2468
R138		1k, 100Ω	1-011-2246
R201		1k	1-011-2270
R202		470Ω	1-011-2262
R203		10k	1-011-2294
R204		0.56Ω ± 10%; 2W, wirewound	1-011-2455
R205		1.5k	1-011-2274
R206		470Ω	1-011-2262
R207		470Ω	1-011-2262
R208		Var; 500Ω ± 20%; 1/5W, composition	1-011-5604
R209		470Ω	1-011-2262
		TRANSFORMER	
T1		Power	1-017-5390
T2		High voltage (TV 12C, TV A12, TV E12)	6-003-0320
	or	High voltage (TV B12, TV C12, TV C12)	6-003-0325
	or	High voltage (TV 9, TI)	6-003-0428
	or	High voltage (5" CRT)	6-003-0328
	or	High voltage (TV 5/I)	6-003-0508
	or	High voltage (TV 9)	6-003-0348
	or	High voltage (TV-12/CC)	6-003-0413
	or	High voltage (TV J12)	6-003-0390
	or	High voltage (TV M12)	6-003-0400
	or	High voltage (TV 9/NC)	6-003-0487
T101		Horizontal driver	1-017-5338
	or	horizontal driver	1-017-5402
VR101		1N758	1-021-0180
VR102		VR56	1-021-0420
VR201		1N752	1-021-0412

MISCELLANEOUS

Socket, CRT (TV 12)	1-022-0427
Socket, CRT (TV 5)	1-022-0430
Fuseholder, extractor post, fuse size: ¼ X 1¼	1-028-0210
Fuseholder, extractor post, fuse size: 9/32 X 1¼ (TV B12 only)	1-028-0246
Low voltage circuit board assembly	6-002-0459
Main chassis circuit board assy. (TV 12, TV B12, TV E12, and TV D12) W/PS	6-002-0500
Main chassis circuit board assy. (TV-TC12, TV 12)	6-002-0502
Main chassis circuit board assy. (TV-5)	6-002-0501
Main chassis circuit board assy. (TV-C12)	6-002-0504
Main chassis circuit board assy. (TV-12, Tektronics)	6-002-0506
Main chassis circuit board assy. (TV-9) W/PS	6-002-0505
Main chassis circuit board assy. (TV-9)	6-002-0515
Main chassis circuit board assy. (TV-G12)	6-002-0530
Main chassis circuit board assy. (TV-C5)	6-002-0516
Main chassis circuit board assy. (TV-M12)	6-002-0532
Main chassis circuit board assy. (TV-9/RI)	6-002-0543
Main chassis circuit board assy. (TV-12/IM)	6-002-0547
Main chassis circuit board assy. (TV-D12)	6-002-0538
Main chassis circuit board assy. (TV-D12 W/O PS)	6-002-0549
Main chassis circuit board assy. (TV-12 W/R102)	6-002-0553
Main chassis circuit board assy. (TV-12/B)	6-002-0555
Main chassis circuit board assy. (TV-9 W/R102)	6-002-0557
Main chassis circuit board assy. (TV-12/Q)	6-002-0559
Main chassis circuit board assy. (TV-9/CO)	6-002-0563
Main chassis circuit board assy. (TV-9/E)	6-002-0565
Main chassis circuit board assy. (TV-9 W/R102)	6-002-0568
Main chassis circuit board assy. (TV-5/I)	6-002-0570
Main chassis circuit board assy. (TV-9/NC)	6-002-0571
Main chassis circuit board assy. (TV-12/R1)	6-002-0603
Main chassis circuit board assy. (TV-12/R2)	6-002-0605
Main chassis circuit board assy. (TV-E12)	6-002-0606
Main chassis circuit board assy. (TV-E12)	6-002-0607
Main chassis circuit board assy. (TV-12/1N)	6-002-0612
Main chassis circuit board assy. (TV-12 W/C117)	6-002-0613
Main chassis circuit board assy. (TV-12/CD)	6-002-0616
Main chassis circuit board assy. (TV-12/R)	6-002-0621
Main chassis circuit board assy. (TV-12/LSI-3)	6-002-0623
Main chassis circuit board assy. (TV-12)	6-002-0624
Main chassis circuit board assy. (TV-9)	6-002-0625
Main chassis circuit board assy. (TV-12/LS)	6-002-0631
Main chassis circuit board assy. (TV-5/DD)	6-002-0632
Main chassis circuit board assy. (TV-12)	6-002-0637
Main chassis circuit board assy. (TV-12/I)	6-002-0641
Main chassis circuit board assy. (TV-9/TRW)	6-002-0645
Cable assy.; 8 inch	6-004-0630
Cable assy.; 6 inch	6-004-0631
Power supply module (TV-12, 120VAC)	6-003-0371
Power supply module (TV-12, 220VAC)	6-003-0372

		Power supply module (TV-9, 120VAC)	6-003-0369
		Power supply module (TV-B12, 120VAC)	6-003-0368
		Power supply module (TV-B12, 220VAC)	6-003-0370
		Power supply module (TV-9, 220VAC)	6-003-0376
		Deflection coil assy. (TV-12 and 5)	6-004-0321
		Deflection coil assy. (TV-9)	6-004-0325
V1		CRT, 12", P4 phosphor	1-014-0737
	or	CRT, 5", P4 phosphor	1-014-0725
	or	CRT, 9", P4 phosphor	1-014-0748
		Power Cable assy., 120 VAC	6-003-0645
		Power Cable assy., 220 VAC	6-003-0652


NOTES: UNLESS OTHERWISE SPECIFIED
1. SEE SECTION 2.2 OF MANUAL
2. DENOTES MOLEX PIN CONNECTOR.
3. ALL RESISTORS ARE 1/2W±5%.
4. ALL CAPACITORS ARE IN µF.
5. DENOTES PRINTED CIRCUIT CARDE EDGE CONNECTOR.
6. ON MODELS WITH INTERLACE OPTION, CHANGE, C104 TO .005; R117 TO 1K; R118 TO 1.8K; R120 TO 150Ω AND ADD C117, VR102.
7. YOKE LEAD IDENTIFICATION:
P106: BLUE & RED LEADS
P102: BROWN & YELLOW LEADS.
8 R129 IS 3Ω ON ALL MODELS EXCEPT TV-E12. TV-E12 - R129 IS 10Ω
+34V
CR107
R101
2.7K
CW
100K 1/8 W
R102 100K
R103
82K
-160V
C119 2.5 50V
C101 .01
GRD
ARC GRD
VIDEO
CONTRAST
CW
500
CARBON COMPOSITION ELEMENT
VERT DRIVE
R113 470
C104 .001
VR101 IN758
VIDEO AND VERT GRD
HORIZ. DRIVE
HORIZ. GRD
V1
T1
P106
TH
YOKE
CR2
R106
P105
R105
T2
P104
BLK
RED
BLU
YEL
ORN
+12KV
Ball Brothers Research Corp.
MIRATEL
TITLE
SCHEMATIC
TV 9 & 12
DRAFTSMAN
CHECKER
DESIGNER
ENGINEER
SIZE D
DRAWING NO. 1-024-0508
REV. U
USED ON
SCALE NONE
SHEET OF 1

1. SEE SECTION 2.2 OF MANUAL
2. ⊣ ← DENOTES MOLEX PIN CONNECTOR.
3. ALL RESISTORS ARE 1 [illegible].
4. [illegible]
5. □ DENOTES PRINTED CIRCUIT CARDE EDGE CONNECTOR.
6. ΔR4 MODELS WITH INTERLACE OPTION, CHANGE; C104 TO .005; R117 TO 1K; R118 TO 1.8K; R120 TO 150Ω AND ADD C117, VR102.

[illegible]

8 R129 IS 3Ω ON ALL MODELS EXCEPT TV-E12. TV-E12 - R129 IS 10Ω.

L1 YOKE YEL BLK P101 P102 -1 -3

+34V +400V CR107 R101 2.7K R104 100K R106 100K

CW 100K 1/8 W R102 100K R103 82K -160V

FOCUS R107 2.5M

C119 2.5 50V C101 .01 C102 .01 C103 .75 pf

GRD 5 ARC GRD

RED GRN WHT BLK 4 BRN 3 YEL 2 BRN/YEL P107 (TO T1) BRN

V1

VIDEO CONTRAST CW 500 CARBON COMPOSITION ELEMENT 8

R109 47 R114 150

+34V R110 820 R112 220 Q101 2N5830

+15V R130 1.2 2W, 10% R132 82 3W, 10%

C107 500 6V R126 680

VERT DRIVE 9 R113 470 C104 .001

R117 4.7K R115 82K VERT FREQ R116 100K

CR101 1N3605 R118 8.2K Q102 2N6027 C105 .47

R121 10K R122 4.7K VERT LIN R123 56 HEIGHT

Q103 MPS-A14 Q104 MJE-3055 R124 250 CR102 1N3605 R125 6.8 2W, 10%

VR101 1N758 C117 6 25V R119 100K R120 560 C106 .47 VR102 VR56

T101 R128 2.7K BLK C115 50 25V R129 C118 820pf R111 47 C114 200 25V

C108 100 6V Q106 CR104 -160V R137 68K 1W C110 .047 C111 .02 R131 3.3K

C113 10 L101 WIDTH P106 -3 -1 YOKE CR2

CR103 C109 .022 +400V CR106 P105

+34V CR105 -2 C112 50 50V P104 -1 -3 P105 -3 T2 BLK BLU YEL RED ORN +2KV

VIDEO AND VERT GRD 10 HORIZ. DRIVE 6 HORIZ. GRD 1 R127 470 Q105 MPS-U05

+15V 1 3 P103

BLK/WHT BLK/YEL BLK/GRN BLK/RED P1 WHT 1 120V 50/60HZ F1 BLK .6A T1

BRN YEL/BRN 3 P107 (TO V1 HEATER) RED CR1 RED/WHT C1 3300 60V RED YEL BLK P201

Q1 2N5067/ 2N3055 BLU GRY YEL P202 3 2 1 R204 .47, 2W, 5%

Q201 2N3053 R201 1K R202 470 C201 50 50V

R205 1.5K Q203 2N3903 Q202 2N3903 C202 .01

R207 470 ORN C203 50 50V R208 500 VOLTAGE ADJUST BLK P203 3

R203 10K VR201 1N752 5.6V R206 470 R209 470

OPTIONAL T1 1 WHT BLK/WHT 3 YEL BLK/YEL BLK/GRN BLK/RED 240V 50/60HZ 220V 50/60HZ 4 BLK F1 BLK .3 A

MOLEX CONNECTOR

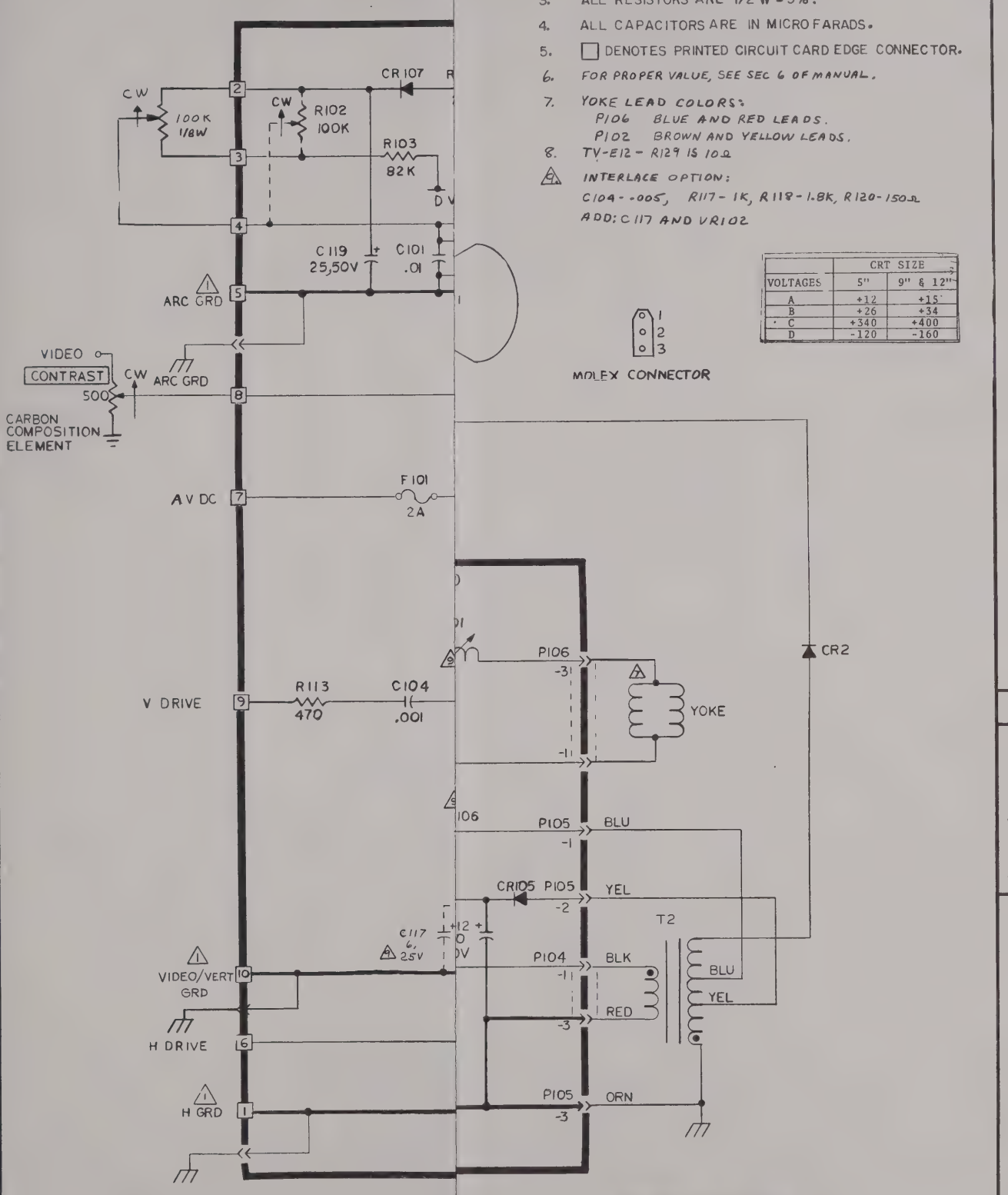
MIRATEL	BALL BROTHERS RESEARCH CORP.		TITLE	SCHEMATIC TV 9 & 12	
	SIGNATURE	DATE	SIZE	DRAWING NO.	REV.
DRAFTSMAN	[illegible]	[illegible]	D	1-324-0508	U
CHECKER	P.W. Keller	6-10-75	USED ON		
DESIGNER			SCALE	NONE	SHEET
ENGINEER	W. Rabe	6/9/75			OF 1

NOTES: UNLESS OTHERWISE SPECIFIED.

1. SEE SECTION 2.2 OF MANUAL.
2. ⊣← DENOTES MOLEX PIN CONNECTOR.
3. ALL RESISTORS ARE 1/2 W ± 5%.
4. ALL CAPACITORS ARE IN MICRO FARADS.
5. ☐ DENOTES PRINTED CIRCUIT CARD EDGE CONNECTOR.
6. FOR PROPER VALUE, SEE SEC 6 OF MANUAL.
7. YOKE LEAD COLORS:
   P106 BLUE AND RED LEADS.
   P102 BROWN AND YELLOW LEADS.
8. TV-E12 - R129 IS 10Ω
9. INTERLACE OPTION:
   C104 - .005, R117 - 1K, R118 - 1.8K, R120 - 150Ω
   ADD: C117 AND VR102

VOLTAGES	CRT SIZE 5"	CRT SIZE 9" & 12"
A	+12	+15
B	+26	+34
C	+340	+400
D	-120	-160

MOLEX CONNECTOR



1-024-0509 M

Ball MIRATEL — BALL BROTHERS RESEARCH CORP.		TITLE: SCHEMATIC TV 5,9,12	
	SIGNATURE	DATE	SIZE / DRAWING NO. / REV.
DRAFTSMAN	L. Fessenden	1-7-76	D / 1-024-0509 / M
CHECKER	T.W. Keller	1/17/75	USED ON: VERSION BA
DESIGNER			SCALE: NONE
ENGINEER	W. Bailey	1-20-75	SHEET: 1 of 1
PROD. VER. BA			

NOTES: UNLESS OTHERWISE SPECIFIED.

1. ⚠ SEE SECTION 2.2 OF MANUAL.
2. ⊣← DENOTES MOLEX PIN CONNECTOR.
3. ALL RESISTORS ARE 1/2 W ± 5%.
4. ALL CAPACITORS ARE IN MICRO FARADS.
5. ☐ DENOTES PRINTED CIRCUIT CARD EDGE CONNECTOR.
6. FOR PROPER VALUE, SEE SEC 6 OF MANUAL.
7. YOKE LEAD COLORS:
   P106 BLUE AND RED LEADS.
   P102 BROWN AND YELLOW LEADS.
8. TV-E12 - R129 IS 10Ω
- ⚠4 INTERLACE OPTION:
  C104 - .005, R117 - 1K, R118 - 1.8K, R120 - 150Ω
  ADD: C117 AND VR102

VOLTAGES	CRT SIZE 5"	CRT SIZE 9" & 12"
A	+12	+15
B	+26	+34
C	+340	+400
D	-120	-160

MOLEX CONNECTOR

1 2 3

CW 100K 1/8W
CW R102 100K
R103 82K
B V
CR107
R101 2.7K
C V
R104 100K
R106 100K
FOCUS R107 2.5M
D V
C119 25,50V
C101 .01
C102 .01
C103 .01
ARC GRD
VIDEO CONTRAST 500 CW
CARBON COMPOSITION ELEMENT
ARC GRD
A V DC
F101 2A
R109 47
L1
YOKE
YEL
BLK
P101 -1 -3
P102 -1 -3
RED
ORN
WHT
BLK
BRN
YEL
9" 12" CRT B15
5" CRT B12
+ BV
R110 820
R112 220
Q101 2N5830
R108
V1
R114 (5") 68 (9&12") 150
R115 82K
R116 100K
VERT FREQ
R117 4.7K
R118 8.2K
R113 470
C104 .001
V DRIVE
CR101 IN3605
Q102 2N6027
C105 .47
R121 10K
R122 4.7K
VERT LIN
R123 56
R124 HEIGHT 250
Q104 MJE3055
CR102 IN3605
R125 6.8 2W, 10%
C117 6, 25V
VR101 IN758
R119 100K
R120 560
C106 .47
VR102 VR56
VIDEO/VERT GRD
H DRIVE
R127 470
H GRD
C107 500, 6V
R126 680
R132 82 3W, 10%
R130 1.2 2W, 10%
T101
R128 2.7K
BLK
R129 3
C108 100 6V
Q106
C115 50 25V
C114 200 25V
C118 820pF
R111 47
CR104
Q105 MPSU05
DV
R137 68K 1W
C110 .047
C111 .02
C116 (5" ONLY) 20 150V
C113 10
L101
CR103
C109 .022
P106 -3 -1
YOKE
CR2
C V
CR106
P105 -1 BLU
BV
CR105 P105 -2 YEL
R131 3.3K
C112 50 50V
T2
P104 -1 BLK
-3 RED
BLU
YEL
P105 -3 ORN

1-024-0509 M

MIRATEL

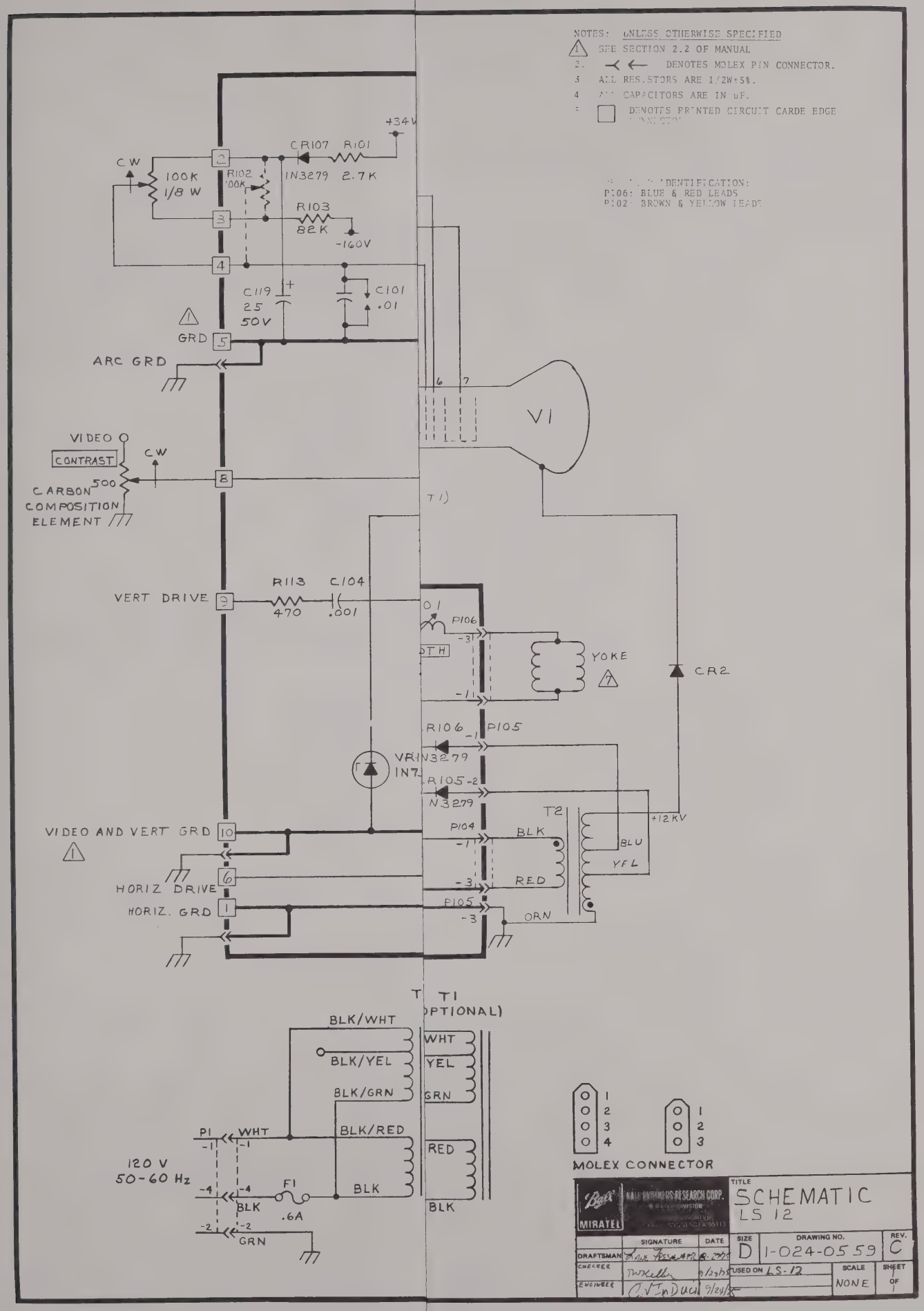
	SIGNATURE	DATE
DRAFTSMAN		
CHECKER		11/11/75
DESIGNER		
ENGINEER		

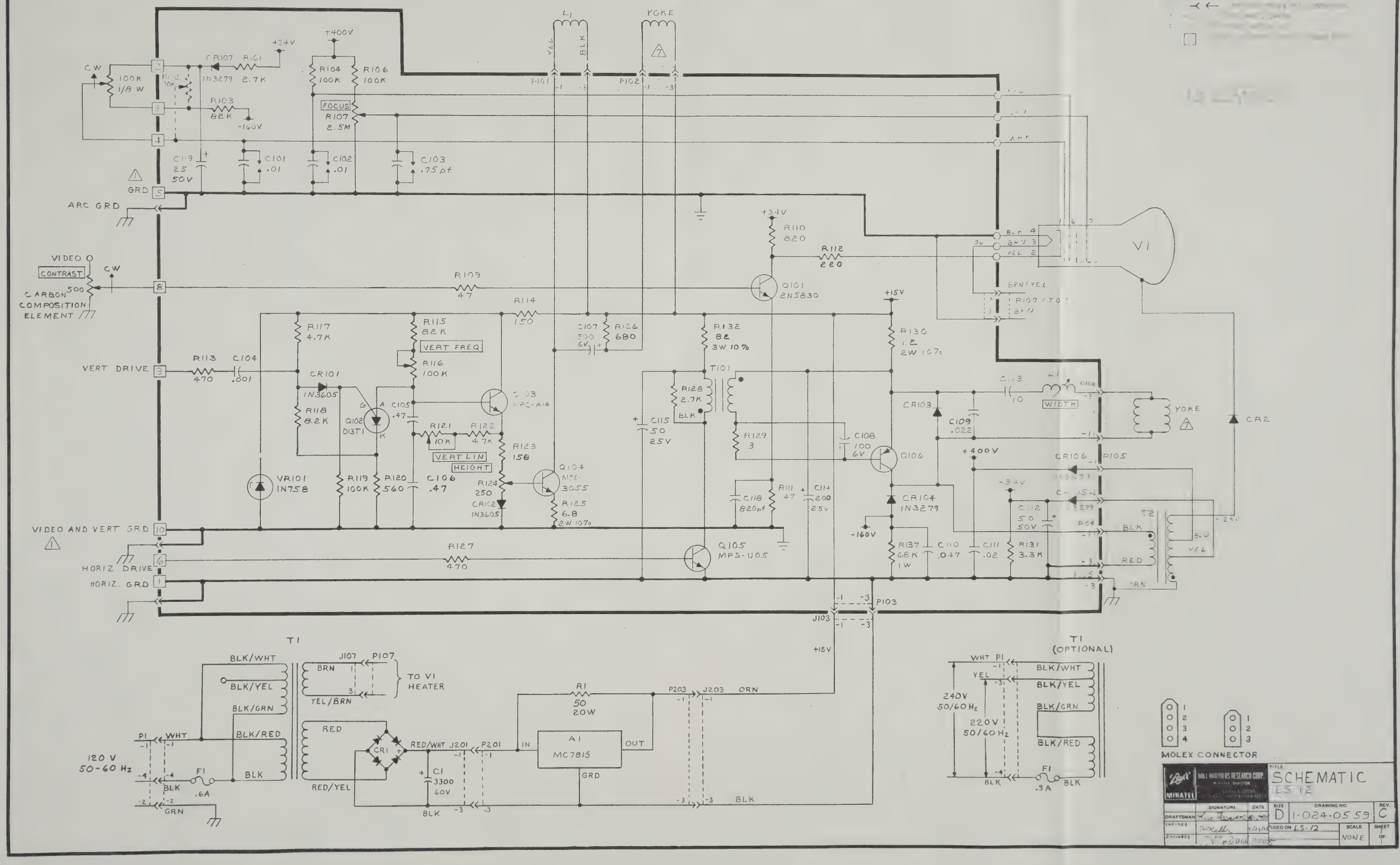
PROD. VER. BA

TITLE: SCHEMATIC TV 5,9,12

SIZE D | DRAWING NO. 1-024-0509 | REV. M

USED ON: VERSION BA | SCALE: NONE | SHEET 1 of 1


NOTES: UNLESS OTHERWISE SPECIFIED
1. SEE SECTION 2.2 OF MANUAL
2. ≺ ← DENOTES MOLEX PIN CONNECTOR.
3. ALL RESISTORS ARE 1/2W±5%.
4. ALL CAPACITORS ARE IN uF.
5. □ DENOTES PRINTED CIRCUIT CARDE EDGE CONNECTOR
WIRE IDENTIFICATION:
P106: BLUE & RED LEADS
P102: BROWN & YELLOW LEADS
+34V
CR107
R101
2.7K
IN3279
CW
100K
1/8 W
R102
100K
R103
82K
-160V
C119
25
50V
C101
.01
GRD
ARC GRD
VIDEO CONTRAST
CW
500
CARBON COMPOSITION ELEMENT
V1
T1)
R113
470
C104
.001
VERT DRIVE
P106
YOKE
CR2
R106
P105
VR
IN3279
IN3279
VIDEO AND VERT GRD
HORIZ DRIVE
HORIZ. GRD
T2
+12KV
P104
BLK
BLU
YEL
RED
P105
ORN
T1
(OPTIONAL)
BLK/WHT
BLK/YEL
BLK/GRN
BLK/RED
WHT
YEL
GRN
RED
BLK
P1
120 V
50-60 Hz
F1
.6A
GRN
MOLEX CONNECTOR
MIRATEL
TITLE
SCHEMATIC
LS 12
SIZE
D
DRAWING NO.
1-024-0559
REV.
C
DRAFTSMAN
CHECKER
ENGINEER
USED ON LS-12
SCALE
NONE
SHEET
OF
1



MITAT	Data I/O Corporation, Research Drive, Redmond, WA 98052		TITLE: SCHEMATIC LS-12		
	SIGNATURE	DATE	SIZE: D	DRAWING NO.: 1-024-0559	REV.: C
DRAFTSMAN					
CHECKER			USED ON: LS-12	SCALE: NONE	SHEET: OF 1
ENGINEER					

Section 7

ORDERING AND RETURNING PARTS

7.1 ORDERING PARTS

Most parts contained in the monitor are available commercially from electronic parts outlets. When it is necessary to order spare or replacement parts from BBRC, Electronic Display Division (E.D. Div.), include the part description, part number, model and serial number data of the monitor as listed on the serial number plate and, if applicable, the schematic reference number listed in the parts list. Orders for these parts should be sent to:

Ball Brothers Research Corporation
Electronic Display Division
P. O. Box 43376
St. Paul, Minnesota 55164

For rapid service: Telephone area (612) 786-8900
or
TWX area (910) 563-3552

7.2 RETURNING PARTS

When the monitor requires service or repair in accordance with the enclosed warranty, return the unit or part to:

Ball Brothers Research Corporation
Electronic Display Division
4501 Ball Road N.E.
Circle Pines,Minnesota 55014

ATTN: Customer Service

Telephone area (612) 786-8900
TWX area (910) 563-3552

Unnecessary delays may be avoided when parts are returned to E.D. Div. using the following procedures:

(1) Package the unit or part in accordance with the method of shipment. Enclose a list of the material being returned and the reason for returning it.

(2) Send the unit or part, transportation prepaid, to the address stipulated for returning parts.

All equipment and parts described in the warranty will be replaced, provided E.D. Div.'s examination discloses that the defects are within the limits of the warranty. If damages or defects are not within the limits of the warranty, the customer will be notified of the extent of repairs required and the cost. The unit will be repaired and returned upon agreement.

INSTALLATION AND OPERATING MANUAL

MALFUNCTION REPORT

Dear Customer:

We are trying to manufacture the most reliable product possible. You would do us a great courtesy by completing this form should you experience any failures.

1. Type Unit _____ Serial No. _____

   Module (if applicable) _____

2. Part failed (Name and Number) _____

3. Cause of failure (if readily available) _____

   _____

   _____

   _____

4. Approximate hours/days of operation to failure _____

5. Failure occurred during:

   Final Inspection Customer Installation Field Use

6. Personal Comment:

   _____

   _____

   _____

Customer _____

Address _____

Signed _____

Date _____

Electronic Display Division
P.O. Box 43376
St. Paul, Minnesota 55164
Telephone 612-786-8900 TWX 910-563-3552

LOST OR DAMAGED EQUIPMENT

The goods described on your Packing Slip have been received by the Transportation Company complete and in good condition. If any of the goods called for on this Packing Slip are short or damaged, you must file a claim **WITH THE TRANSPORTATION COMPANY FOR THE AMOUNT OF THE DAMAGE AND/OR LOSS.**

IF LOSS OR DAMAGE IS EVIDENT AT TIME OF DELIVERY:

If any of the good called for on this Packing Slip are short or damaged at the time of delivery, **ACCEPT THEM, but only if the Freight Agent makes a damaged or short notation on your Freight Bill or Express Receipt and signs it.**

IF DAMAGE OR LOSS IS CONCEALED AND DISCOVERED AT A LATER DATE:

If any concealed loss or damage is discovered, notify your local Freight Agent or Express Agent **AT ONCE** and request him to make an inspection. This is absolutely necessary. Unless you do this, the Transportation Company will not consider any claim for loss or damage valid. If the agent refuses to make an inspection, you should draw up an affidavit to the effect that you notified him on a certain date and that he failed to make the necessary inspection.

After you have ascertained the extent of the loss or damage, **ORDER THE REPLACEMENT PARTS OF COMPLETE NEW UNITS FROM THE FACTORY.** We will ship to you **and bill you for the cost.** This new invoice will then be a part of your claim for reimbursement from the Transportation Company. This, together with other papers, will properly support your claim.

Remember, it is extremely important that you **do not give the Transportation Company a clear receipt if damage or shortages are evident upon delivery.** It is equally important that you call for an inspection if the loss or damage is discovered later. **DO NOT, UNDER ANY CIRCUMSTANCES, ORDER THE TRANSPORTATION COMPANY TO RETURN SHIPMENT TO OUR FACTORY OR REFUSE SHIPMENT UNTIL WE HAVE AUTHORIZED SUCH RETURN.**

IMPORTANT

EQUIPMENT RETURN TO BALL BROS. ELECTRONIC DISPLAY DIVISION

1. Receive return authorization from the plant unless the unit was sent to you upon evaluation or rental.

2. Return prepaid.

3. Be sure a declared value equal to the price of the unit is shown on the bill of lading, express receipt, or air freight bill, whichever is applicable. This would cover claim for shipping damage on return.

WARRANTY

Ball Brothers Research Corporation, Electronic Display Division certifies that each monitor will be free from defective materials and workmanship for one year from date of shipment to the original customer. The only exception will be the receiving tubes and solid state devices (transistors, diodes, etc.). Receiving tubes will carry a 90 day warranty, and the picture tube will have the standard one year warranty. With solid state devices, we will reflect the manufacturers' warranty.

Electronic Display Division agrees to correct any of the above defects when the monitor is returned to the factory prepaid. Written authorization must be obtained and confirmed in writing by the Customer Service Department before returning the monitor to the factory.

Under this warranty, Electronic Display Division will provide the necessary components required by the customer to correct the monitor in the field. The components will be shipped, prepaid, on a billing memo which will be cancelled upon receipt of the defective components at the factory. When ordering components for repair or replacement, the model number and serial number must be included on the customer request.

This warranty is invalid if the monitor is subject to mis-use, abuse, neglect, accident, improper installation or application, alteration or negligence in use, storage, transportation or handling and where the serial number has been removed, defaced or changed.

Ball